JC20 Rec'd PCT/PTO 14 DEC 2001

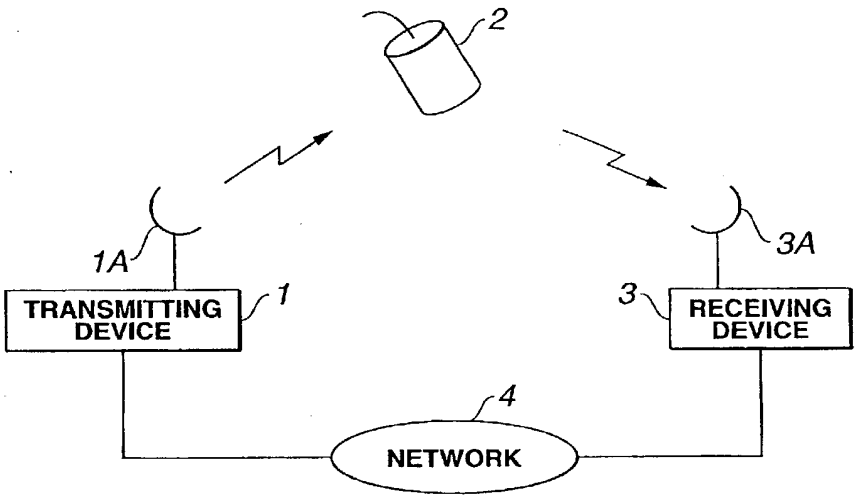



FIG.1

10/019124

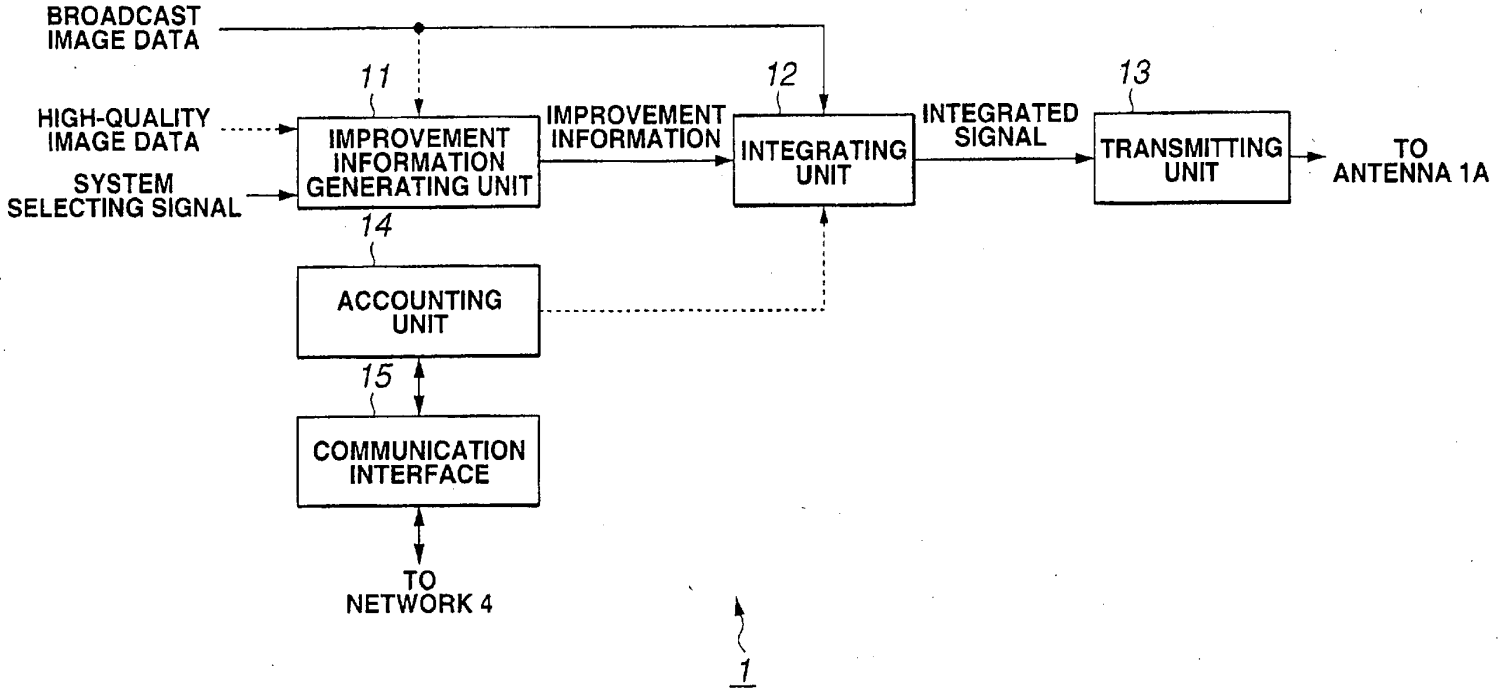



FIG.2

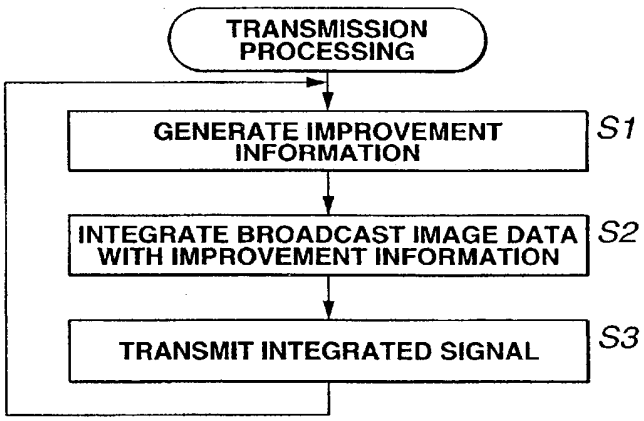

TRANSMISSION PROCESSING
GENERATE IMPROVEMENT INFORMATION
S1
INTEGRATE BROADCAST IMAGE DATA WITH IMPROVEMENT INFORMATION
S2
TRANSMIT INTEGRATED SIGNAL
S3

FIG.3

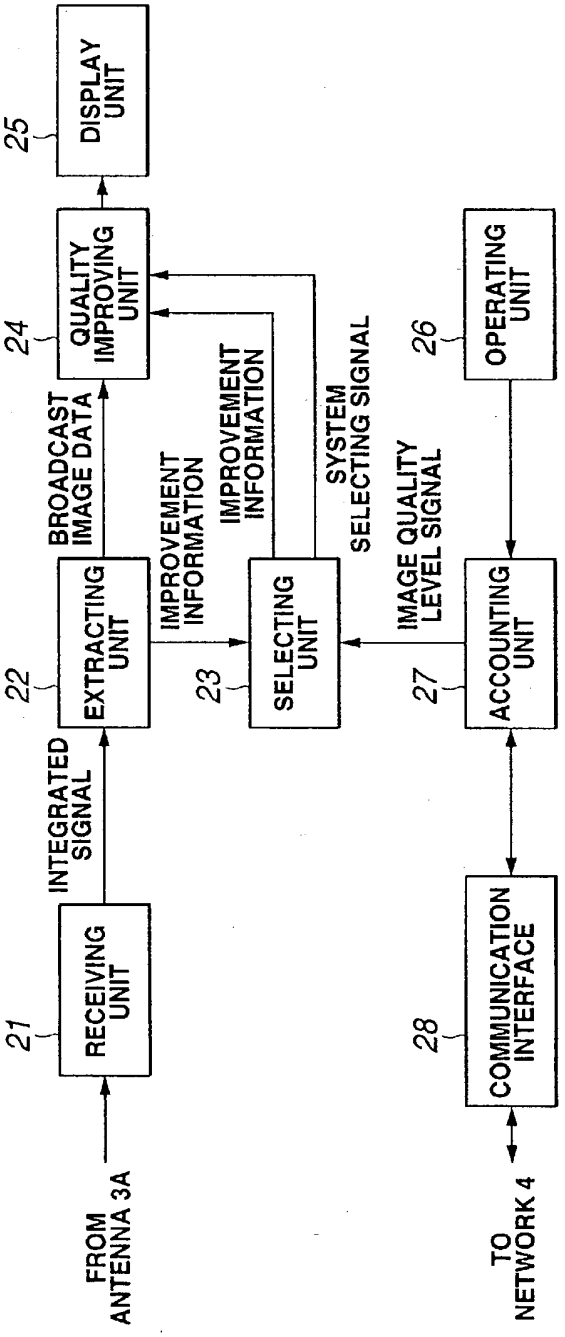

25
DISPLAY UNIT
24
QUALITY IMPROVING UNIT
BROADCAST IMAGE DATA
IMPROVEMENT INFORMATION
SYSTEM SELECTING SIGNAL
26
OPERATING UNIT
22
EXTRACTING UNIT
23
SELECTING UNIT
IMAGE QUALITY LEVEL SIGNAL
INTEGRATED SIGNAL
27
ACCOUNTING UNIT
3
21
RECEIVING UNIT
28
COMMUNICATION INTERFACE
FROM ANTENNA 3A
TO NETWORK 4

FIG.4

Translation of PCT/JP00/04564

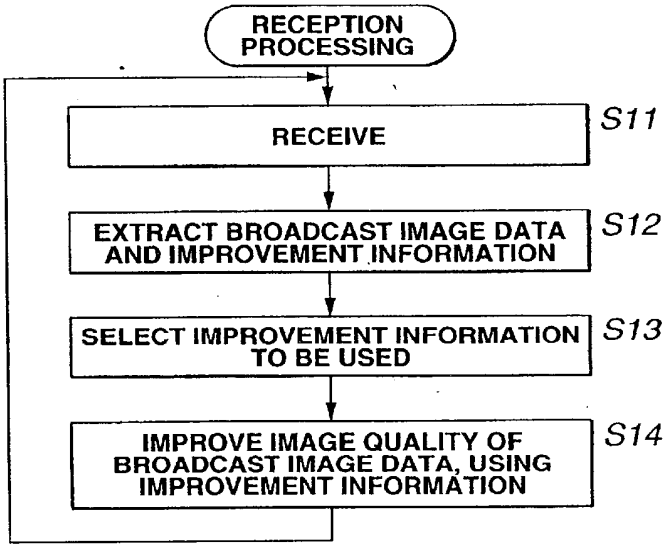



FIG.5

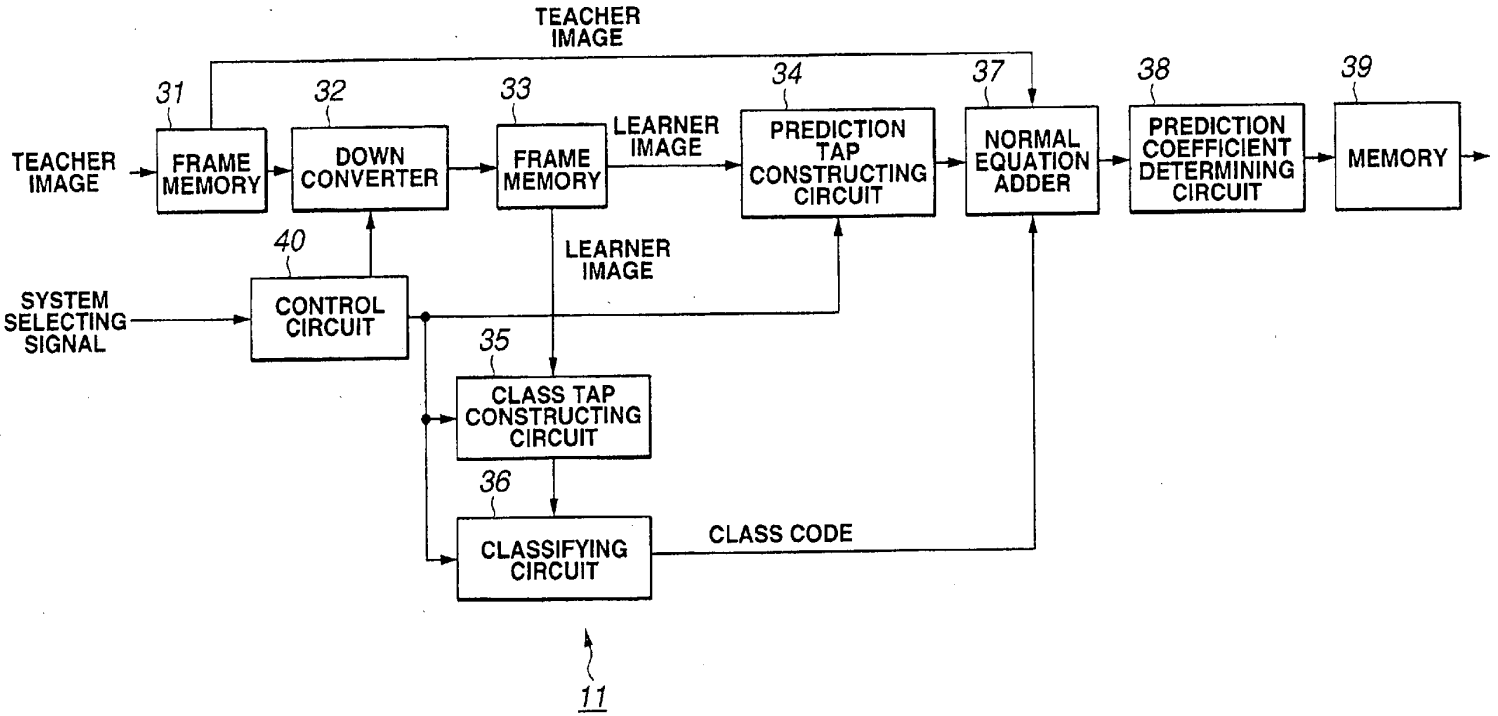



FIG.6

10/019124

EDITION: 10/019124

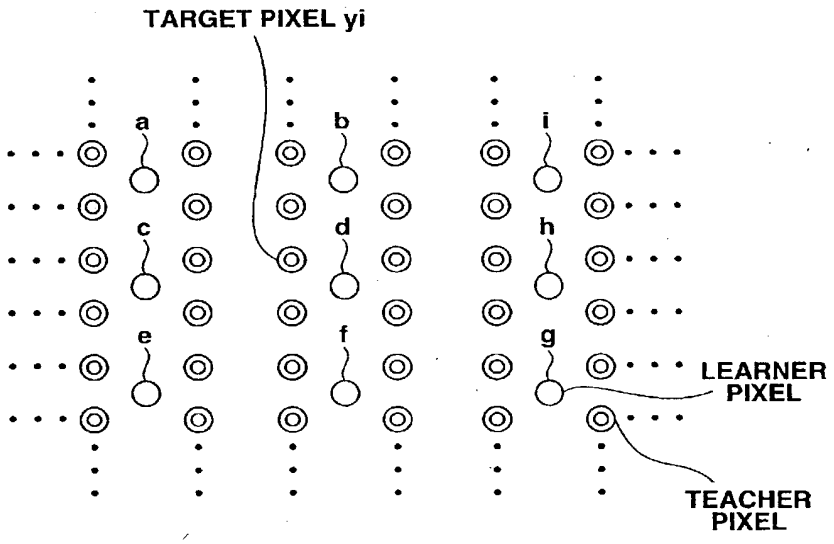



FIG.7

FIG.8A

| SYSTEM SELECTING SIGNAL | IMPROVEMENT SYSTEM |
|---|---|
| 0 | LINEAR INTERPOLATION |
| 1 | ADAPTIVE PROCESSING (MONO-CLASS) |
| 2 | CLASSIFICATION ADAPTIVE PROCESSING |

FIG.8B

| SYSTEM SELECTING SIGNAL | IMPROVEMENT SYSTEM |
|---|---|
| 0 | LINEAR INTERPOLATION |
| 1 | CLASSIFICATION ADAPTIVE PROCESSING (SMALL NUMBER OF CLASSES) |
| 2 | CLASSIFICATION ADAPTIVE PROCESSING (LARGE NUMBER OF CLASSES) |

FIG.8C

| SYSTEM SELECTING SIGNAL | IMPROVEMENT SYSTEM |
|---|---|
| 0 | LINEAR INTERPOLATION |
| 1 | CLASSIFICATION ADAPTIVE PROCESSING (LOW COEFFICIENT PERFORMANCE) |
| 2 | CLASSIFICATION ADAPTIVE PROCESSING (HIGH COEFFICIENT PERFORMANCE) |

FIG.8D

| SYSTEM SELECTING SIGNAL | IMPROVEMENT SYSTEM |
|---|---|
| 0 | LINEAR INTERPOLATION |
| 1 | ADAPTIVE PROCESSING USING CLASSIFICATION BY THRESHOLD VALUE |
| 2 | ADAPTIVE PROCESSING USING CLASSIFICATION BY ADRC |

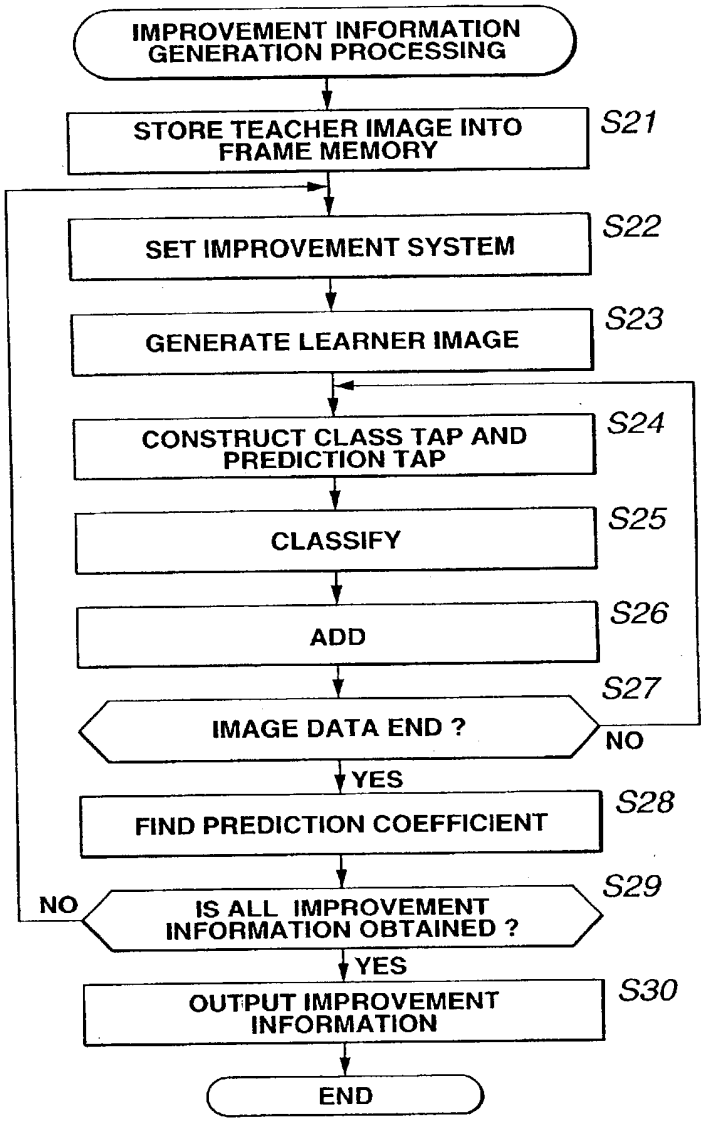

IMPROVEMENT INFORMATION GENERATION PROCESSING
STORE TEACHER IMAGE INTO FRAME MEMORY
S21
SET IMPROVEMENT SYSTEM
S22
GENERATE LEARNER IMAGE
S23
CONSTRUCT CLASS TAP AND PREDICTION TAP
S24
CLASSIFY
S25
ADD
S26
IMAGE DATA END ?
S27
NO
YES
FIND PREDICTION COEFFICIENT
S28
NO
IS ALL IMPROVEMENT INFORMATION OBTAINED ?
S29
YES
OUTPUT IMPROVEMENT INFORMATION
S30
END

FIG.9

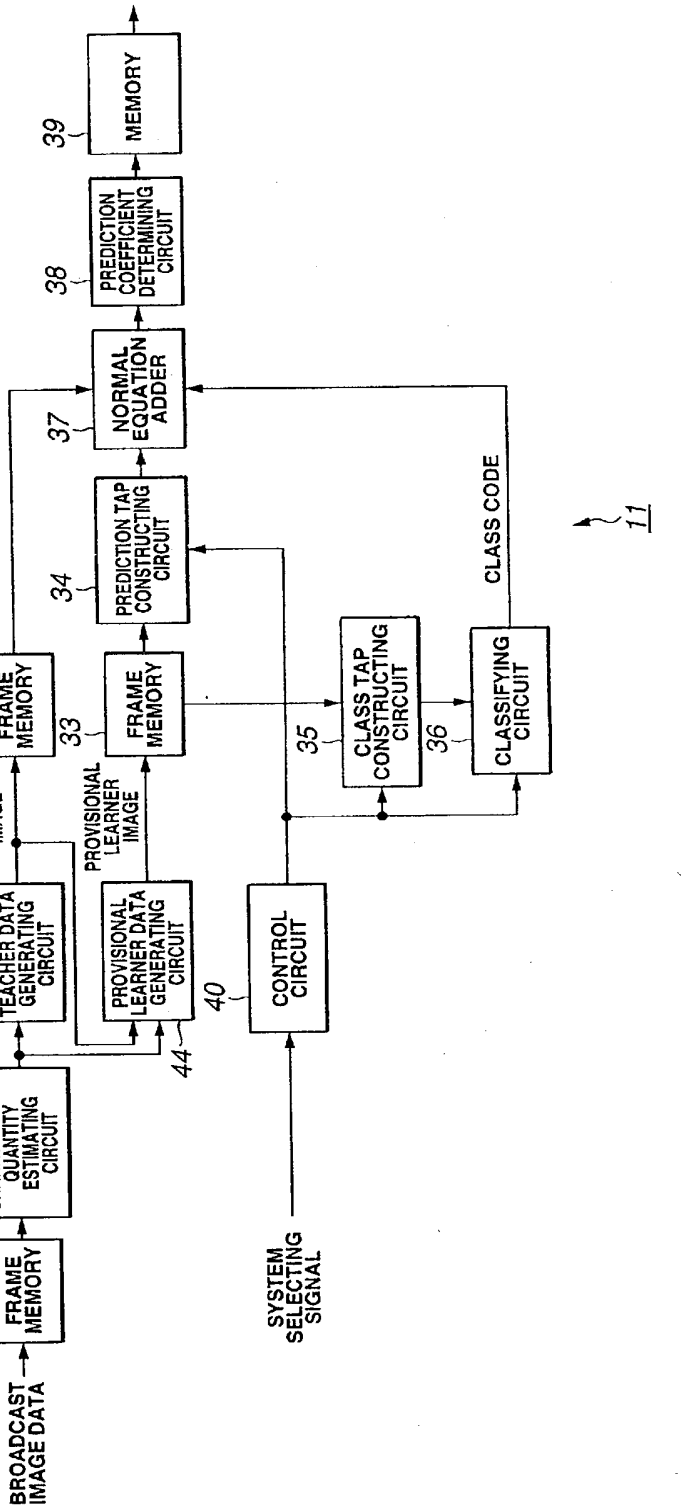

BROADCAST IMAGE DATA
41
FRAME MEMORY
42
CHARACTERISTIC QUANTITY ESTIMATING CIRCUIT
43
PROVISIONAL TEACHER DATA GENERATING CIRCUIT
44
PROVISIONAL LEARNER DATA GENERATING CIRCUIT
40
CONTROL CIRCUIT
SYSTEM SELECTING SIGNAL
PROVISIONAL TEACHER IMAGE
31
FRAME MEMORY
PROVISIONAL LEARNER IMAGE
33
FRAME MEMORY
34
PREDICTION TAP CONSTRUCTING CIRCUIT
35
CLASS TAP CONSTRUCTING CIRCUIT
36
CLASSIFYING CIRCUIT
CLASS CODE
37
NORMAL EQUATION ADDER
38
PREDICTION COEFFICIENT DETERMINING CIRCUIT
39
MEMORY
11

FIG.10

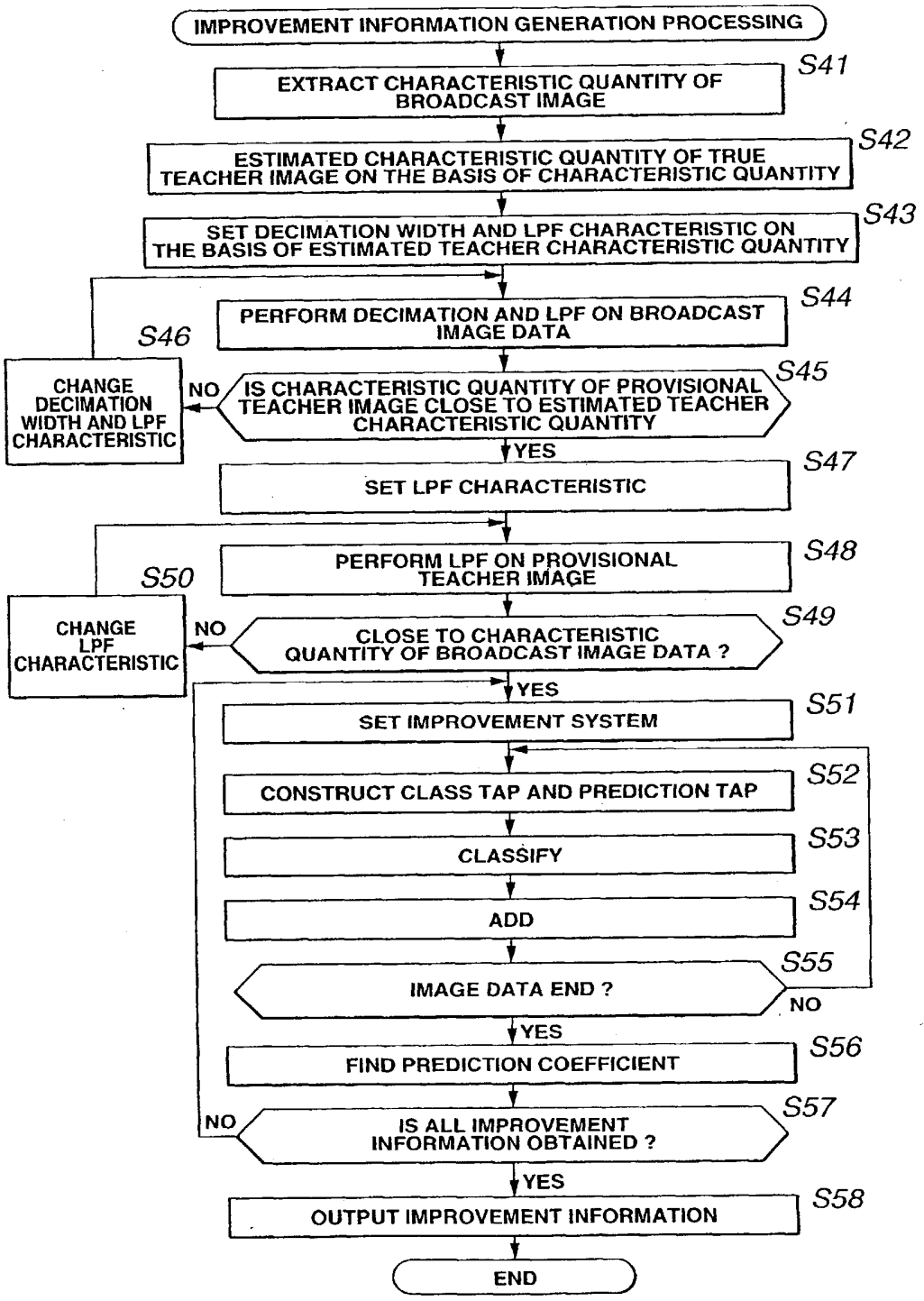

IMPROVEMENT INFORMATION GENERATION PROCESSING
EXTRACT CHARACTERISTIC QUANTITY OF BROADCAST IMAGE
S41
ESTIMATED CHARACTERISTIC QUANTITY OF TRUE TEACHER IMAGE ON THE BASIS OF CHARACTERISTIC QUANTITY
S42
SET DECIMATION WIDTH AND LPF CHARACTERISTIC ON THE BASIS OF ESTIMATED TEACHER CHARACTERISTIC QUANTITY
S43
PERFORM DECIMATION AND LPF ON BROADCAST IMAGE DATA
S44
IS CHARACTERISTIC QUANTITY OF PROVISIONAL TEACHER IMAGE CLOSE TO ESTIMATED TEACHER CHARACTERISTIC QUANTITY
S45
NO
CHANGE DECIMATION WIDTH AND LPF CHARACTERISTIC
S46
YES
SET LPF CHARACTERISTIC
S47
PERFORM LPF ON PROVISIONAL TEACHER IMAGE
S48
CLOSE TO CHARACTERISTIC QUANTITY OF BROADCAST IMAGE DATA ?
S49
NO
CHANGE LPF CHARACTERISTIC
S50
YES
SET IMPROVEMENT SYSTEM
S51
CONSTRUCT CLASS TAP AND PREDICTION TAP
S52
CLASSIFY
S53
ADD
S54
IMAGE DATA END ?
S55
NO
YES
FIND PREDICTION COEFFICIENT
S56
IS ALL IMPROVEMENT INFORMATION OBTAINED ?
S57
NO
YES
OUTPUT IMPROVEMENT INFORMATION
S58
END

FIG.11

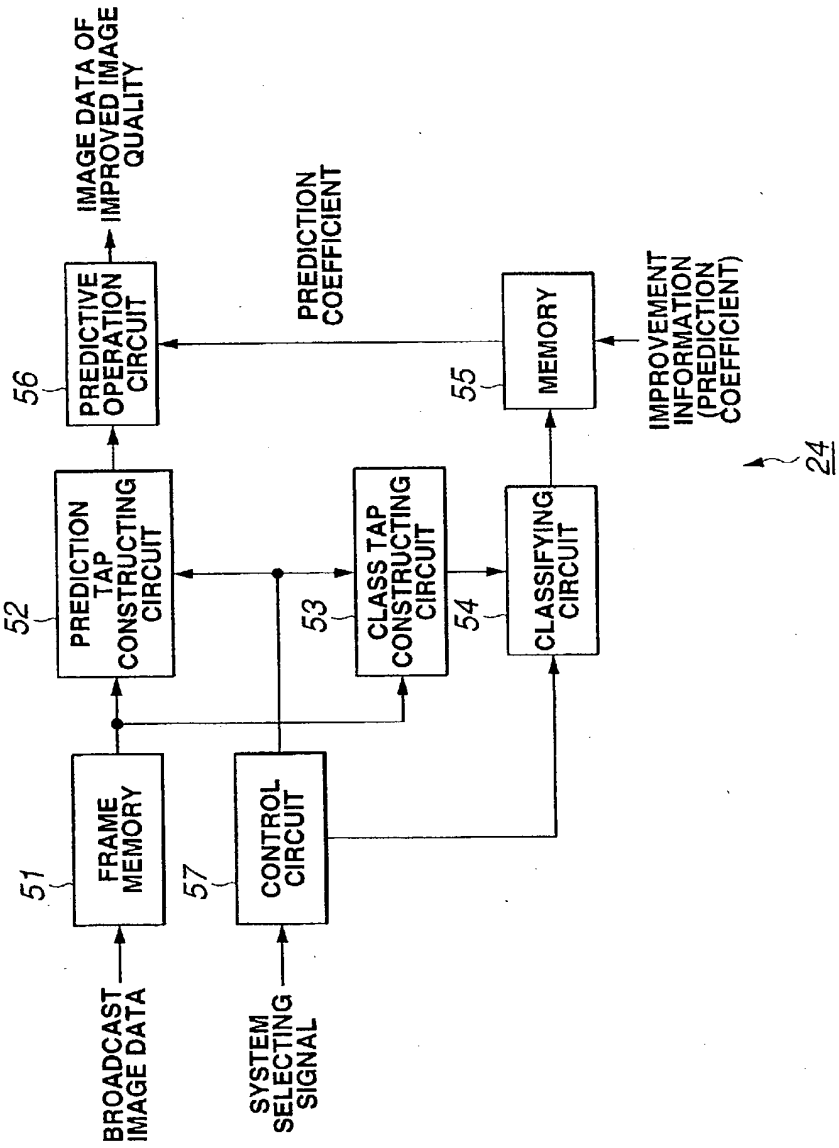

BROADCAST IMAGE DATA
SYSTEM SELECTING SIGNAL
51
FRAME MEMORY
57
CONTROL CIRCUIT
52
PREDICTION TAP CONSTRUCTING CIRCUIT
53
CLASS TAP CONSTRUCTING CIRCUIT
54
CLASSIFYING CIRCUIT
55
MEMORY
IMPROVEMENT INFORMATION (PREDICTION COEFFICIENT)
24
56
PREDICTIVE OPERATION CIRCUIT
PREDICTION COEFFICIENT
IMAGE DATA OF IMPROVED IMAGE QUALITY

FIG.12

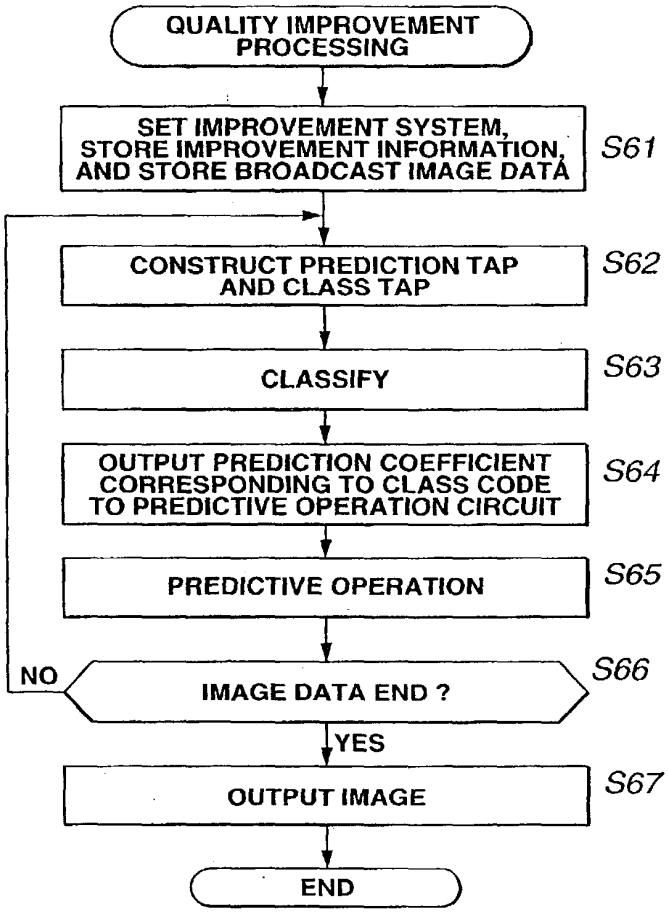

QUALITY IMPROVEMENT PROCESSING
SET IMPROVEMENT SYSTEM, STORE IMPROVEMENT INFORMATION, AND STORE BROADCAST IMAGE DATA
S61
CONSTRUCT PREDICTION TAP AND CLASS TAP
S62
CLASSIFY
S63
OUTPUT PREDICTION COEFFICIENT CORRESPONDING TO CLASS CODE TO PREDICTIVE OPERATION CIRCUIT
S64
PREDICTIVE OPERATION
S65
NO
IMAGE DATA END ?
S66
YES
OUTPUT IMAGE
S67
END

FIG.13

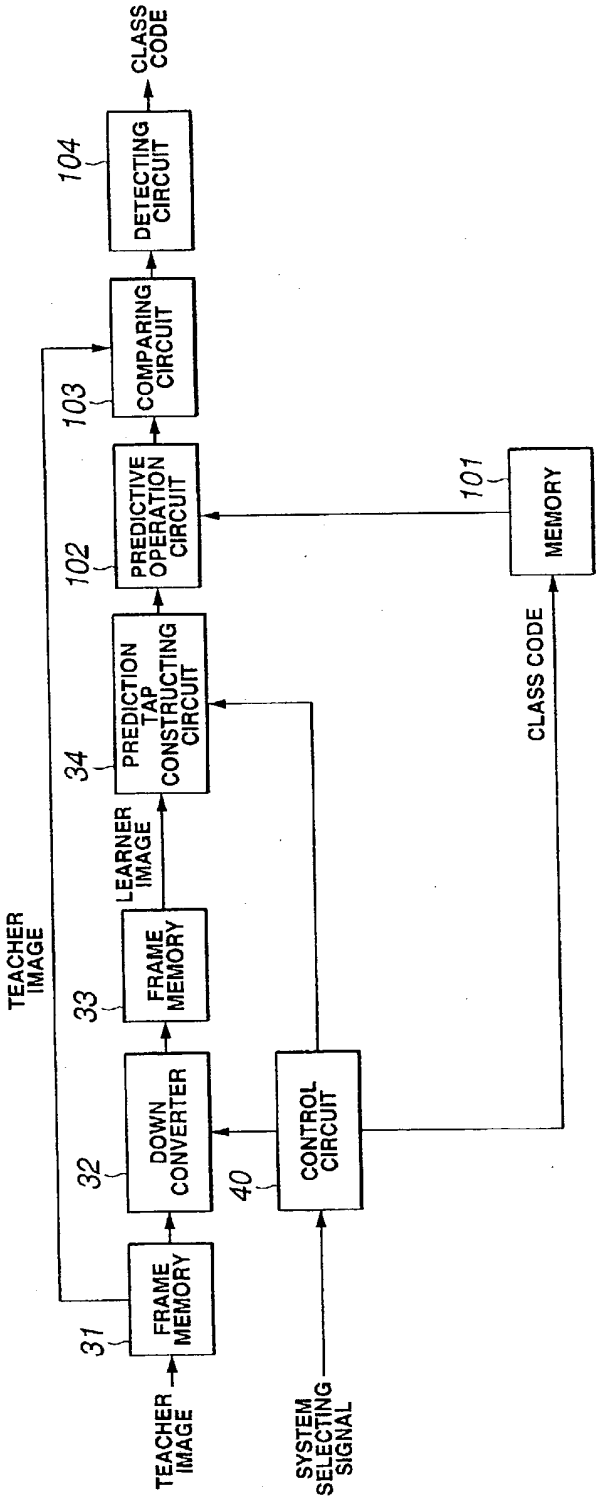

TEACHER IMAGE
SYSTEM SELECTING SIGNAL
31
FRAME MEMORY
32
DOWN CONVERTER
33
FRAME MEMORY
34
PREDICTION TAP CONSTRUCTING CIRCUIT
102
PREDICTIVE OPERATION CIRCUIT
103
COMPARING CIRCUIT
104
DETECTING CIRCUIT
CLASS CODE
LEARNER IMAGE
TEACHER IMAGE
40
CONTROL CIRCUIT
101
MEMORY
CLASS CODE
11

FIG.14

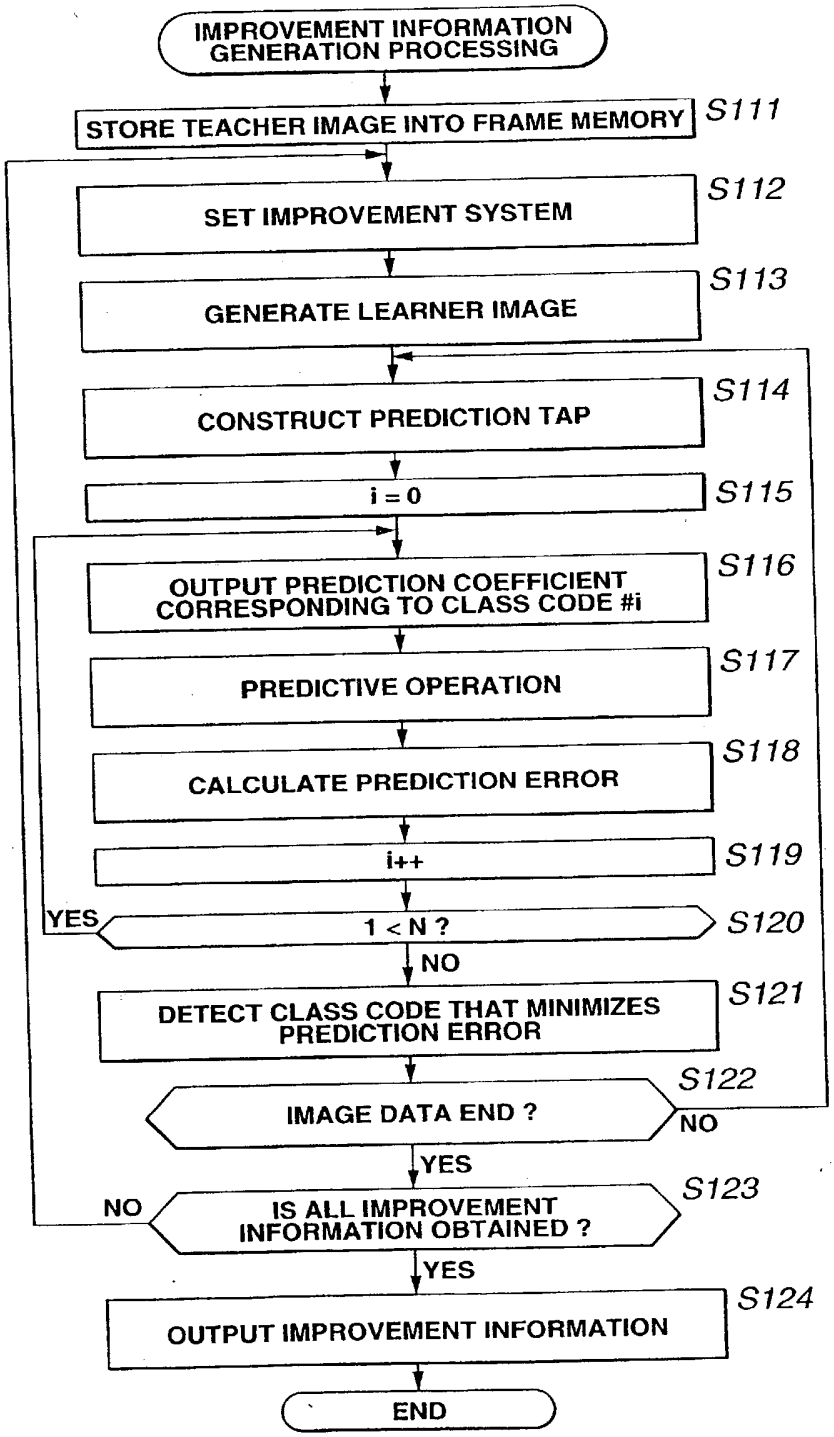

IMPROVEMENT INFORMATION GENERATION PROCESSING
STORE TEACHER IMAGE INTO FRAME MEMORY
S111
SET IMPROVEMENT SYSTEM
S112
GENERATE LEARNER IMAGE
S113
CONSTRUCT PREDICTION TAP
S114
i = 0
S115
OUTPUT PREDICTION COEFFICIENT CORRESPONDING TO CLASS CODE #i
S116
PREDICTIVE OPERATION
S117
CALCULATE PREDICTION ERROR
S118
i++
S119
YES
1 < N ?
S120
NO
DETECT CLASS CODE THAT MINIMIZES PREDICTION ERROR
S121
IMAGE DATA END ?
S122
NO
YES
NO
IS ALL IMPROVEMENT INFORMATION OBTAINED ?
S123
YES
OUTPUT IMPROVEMENT INFORMATION
S124
END

FIG.15

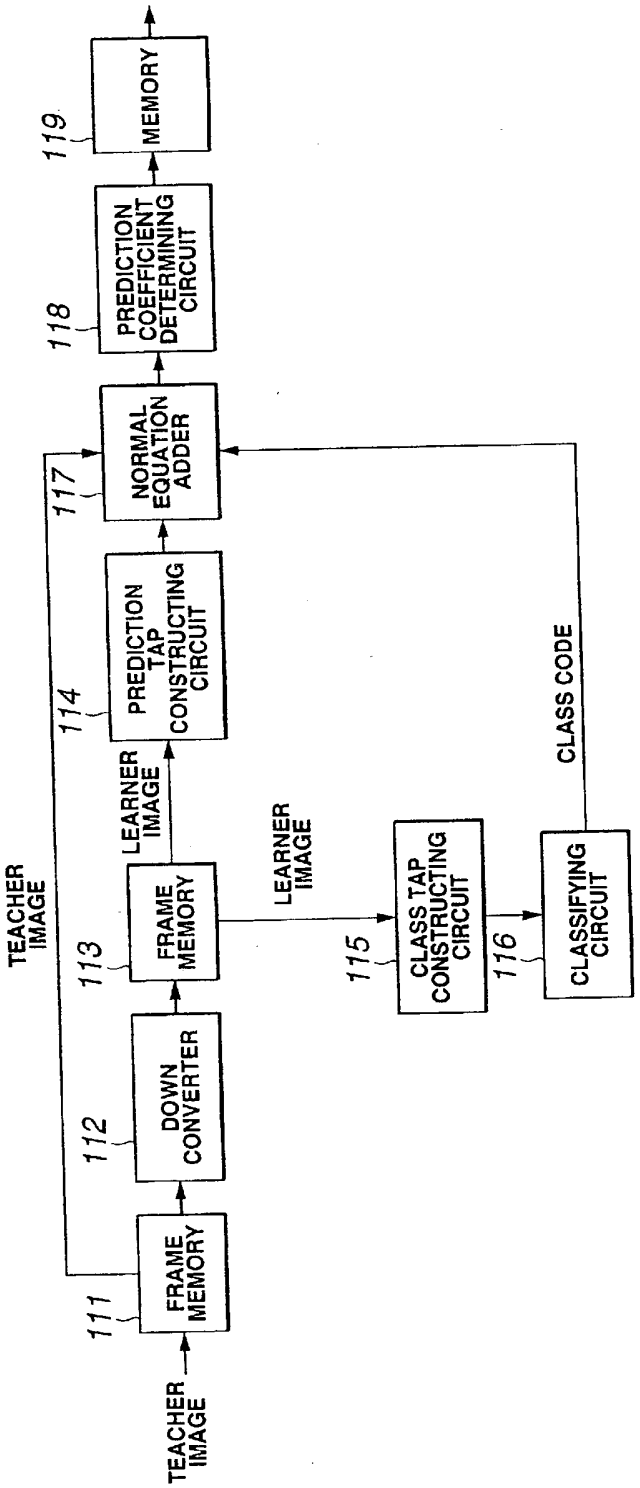

TEACHER IMAGE
111
FRAME MEMORY
112
DOWN CONVERTER
113
FRAME MEMORY
LEARNER IMAGE
114
PREDICTION TAP CONSTRUCTING CIRCUIT
117
NORMAL EQUATION ADDER
118
PREDICTION COEFFICIENT DETERMINING CIRCUIT
119
MEMORY
TEACHER IMAGE
LEARNER IMAGE
115
CLASS TAP CONSTRUCTING CIRCUIT
116
CLASSIFYING CIRCUIT
CLASS CODE

FIG.16

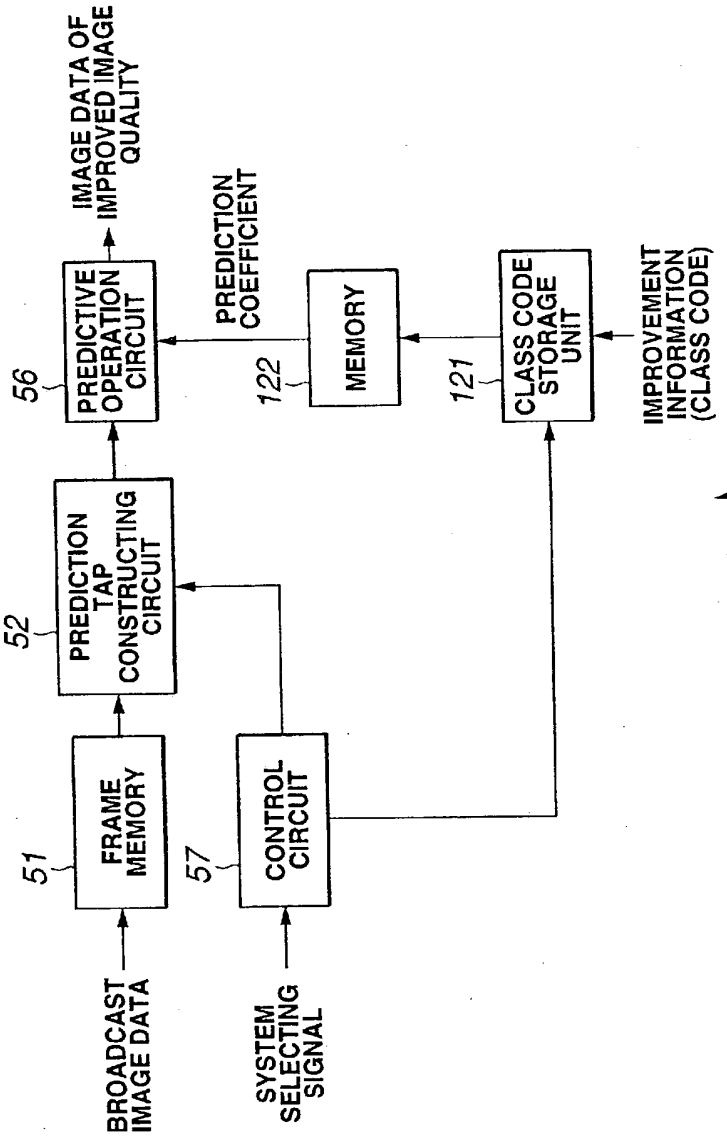

BROADCAST IMAGE DATA
SYSTEM SELECTING SIGNAL
51
FRAME MEMORY
57
CONTROL CIRCUIT
52
PREDICTION TAP CONSTRUCTING CIRCUIT
56
PREDICTIVE OPERATION CIRCUIT
IMAGE DATA OF IMPROVED IMAGE QUALITY
PREDICTION COEFFICIENT
122
MEMORY
121
CLASS CODE STORAGE UNIT
IMPROVEMENT INFORMATION (CLASS CODE)
24

FIG.17

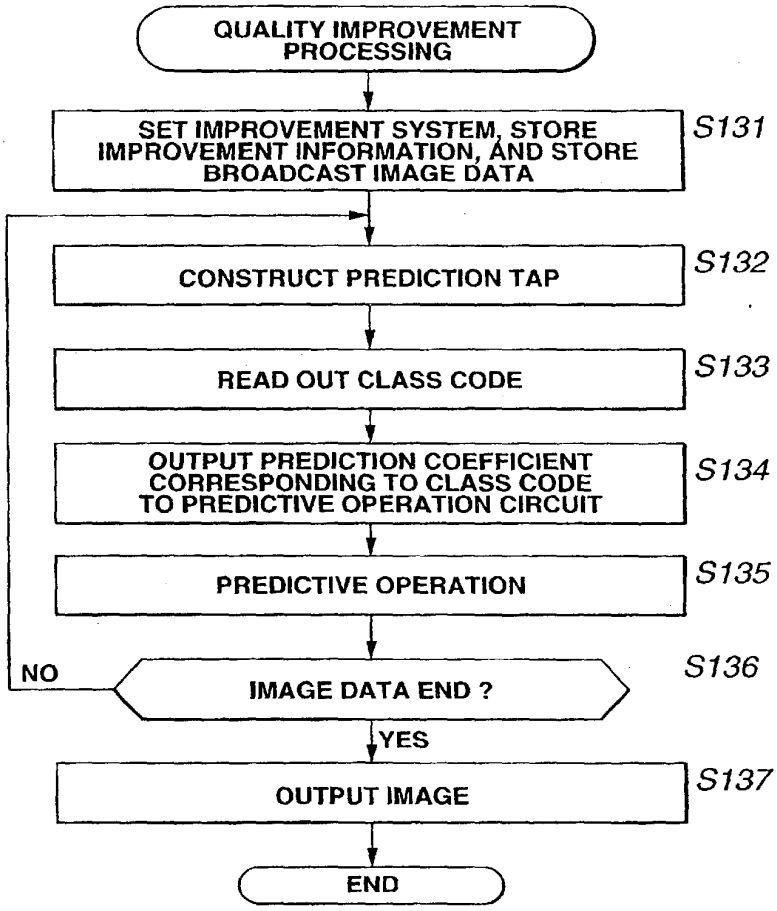

QUALITY IMPROVEMENT PROCESSING
SET IMPROVEMENT SYSTEM, STORE IMPROVEMENT INFORMATION, AND STORE BROADCAST IMAGE DATA
S131
CONSTRUCT PREDICTION TAP
S132
READ OUT CLASS CODE
S133
OUTPUT PREDICTION COEFFICIENT CORRESPONDING TO CLASS CODE TO PREDICTIVE OPERATION CIRCUIT
S134
PREDICTIVE OPERATION
S135
NO
IMAGE DATA END ?
S136
YES
OUTPUT IMAGE
S137
END

FIG.18

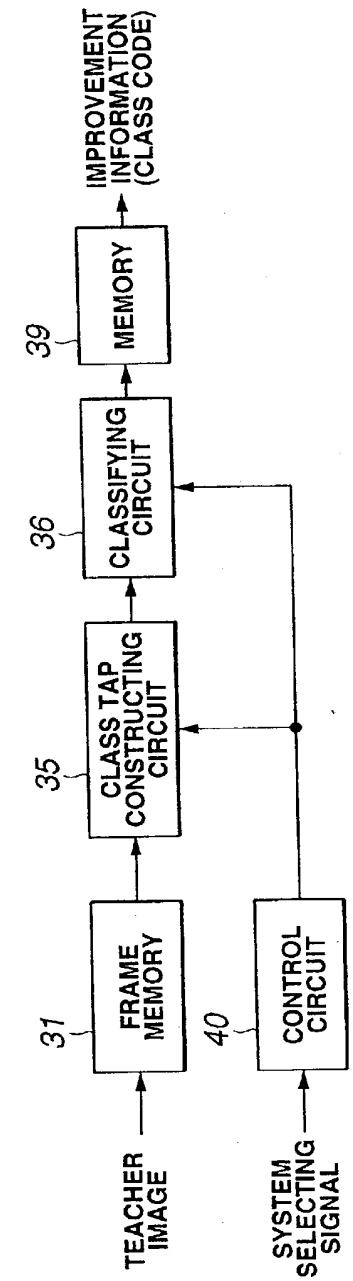

TEACHER IMAGE
SYSTEM SELECTING SIGNAL
31
FRAME MEMORY
40
CONTROL CIRCUIT
35
CLASS TAP CONSTRUCTING CIRCUIT
36
CLASSIFYING CIRCUIT
39
MEMORY
IMPROVEMENT INFORMATION (CLASS CODE)
11

FIG.19

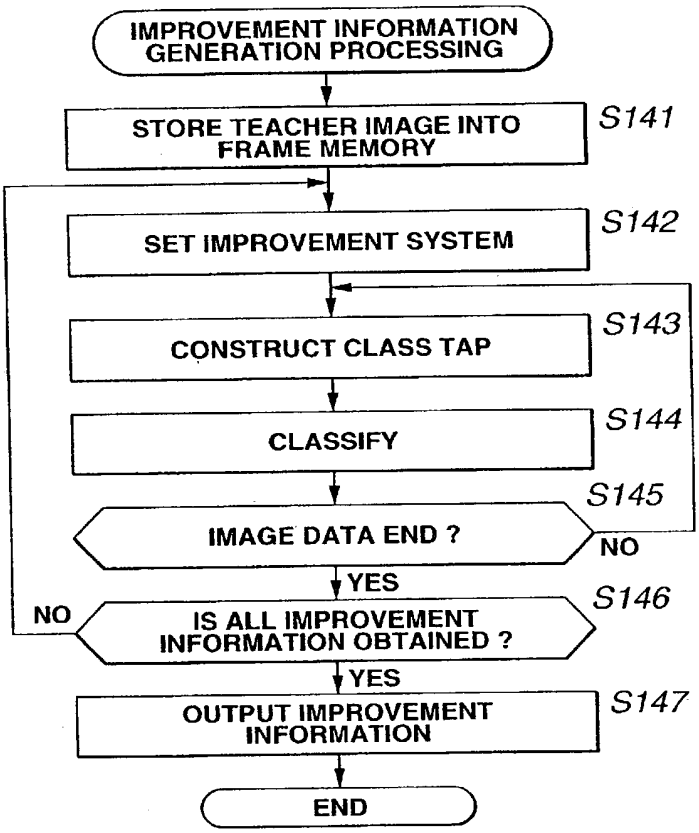

IMPROVEMENT INFORMATION GENERATION PROCESSING
STORE TEACHER IMAGE INTO FRAME MEMORY
S141
SET IMPROVEMENT SYSTEM
S142
CONSTRUCT CLASS TAP
S143
CLASSIFY
S144
IMAGE DATA END ?
S145
NO
YES
IS ALL IMPROVEMENT INFORMATION OBTAINED ?
S146
NO
YES
OUTPUT IMPROVEMENT INFORMATION
S147
END

FIG.20

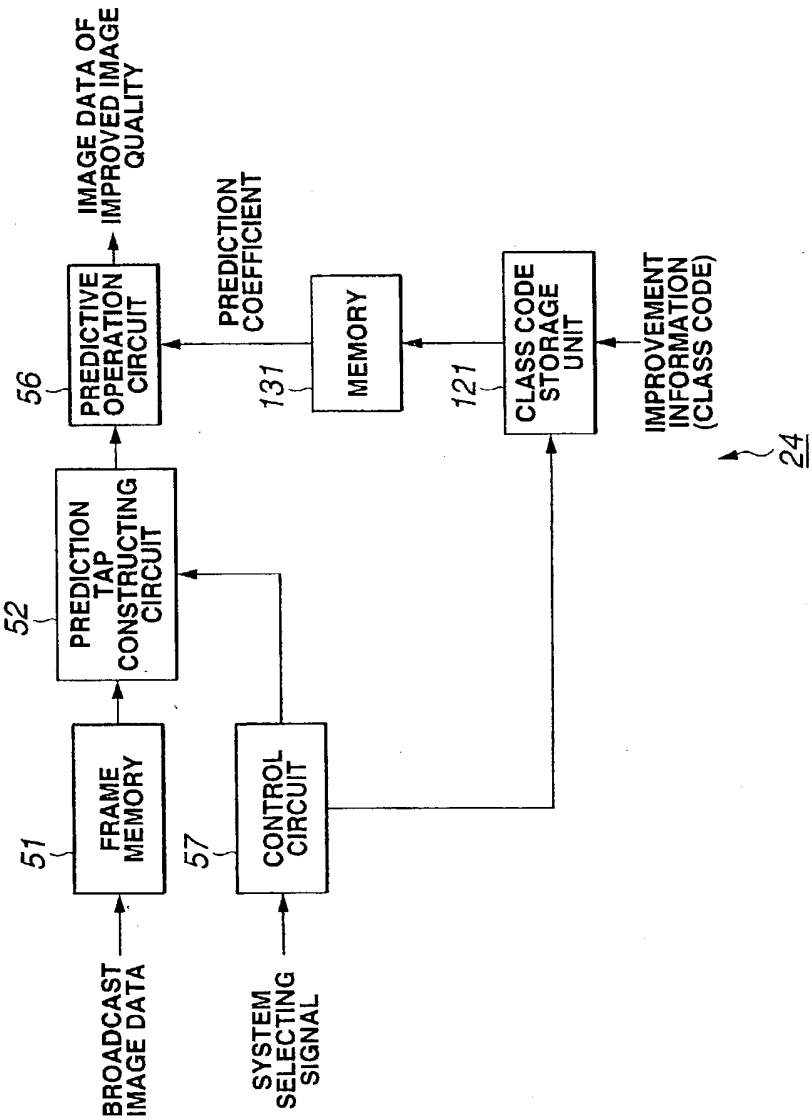

BROADCAST IMAGE DATA
SYSTEM SELECTING SIGNAL
51
FRAME MEMORY
57
CONTROL CIRCUIT
52
PREDICTION TAP CONSTRUCTING CIRCUIT
56
PREDICTIVE OPERATION CIRCUIT
131
MEMORY
121
CLASS CODE STORAGE UNIT
IMPROVEMENT INFORMATION (CLASS CODE)
24
PREDICTION COEFFICIENT
IMAGE DATA OF IMPROVED IMAGE QUALITY

FIG.21

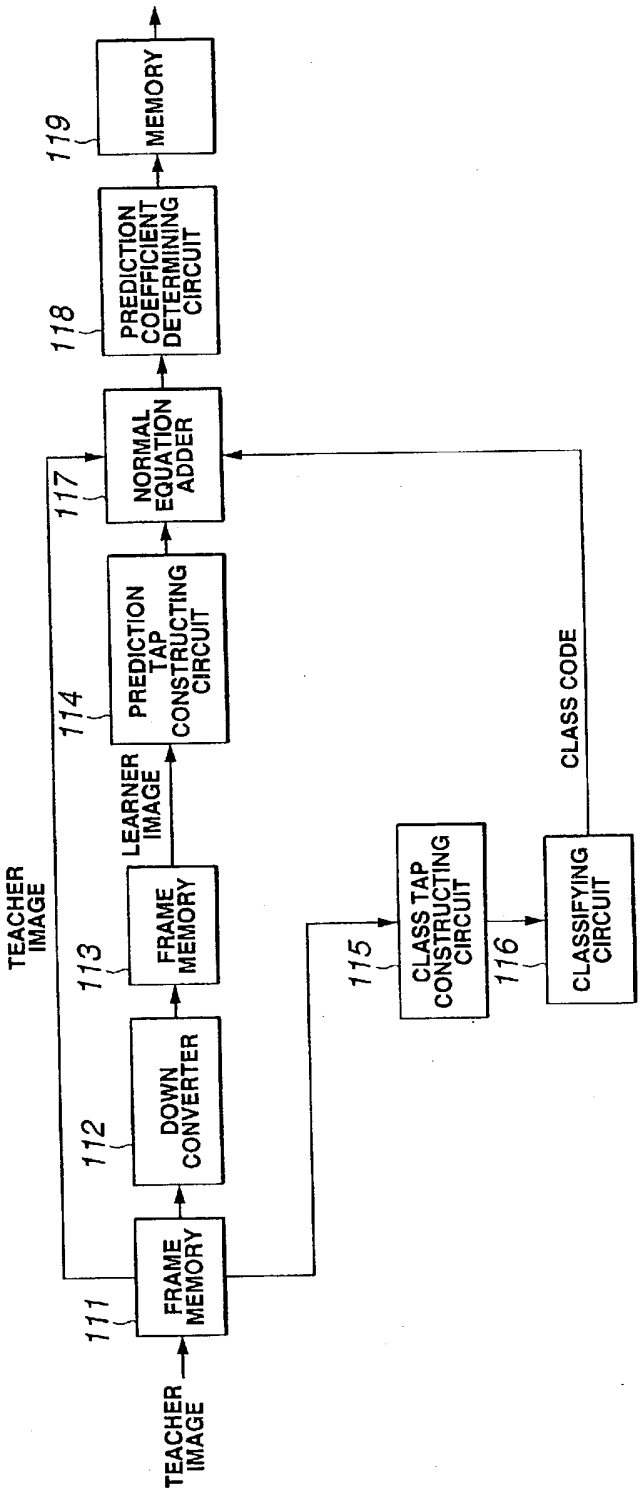

TEACHER IMAGE
111
FRAME MEMORY
112
DOWN CONVERTER
113
FRAME MEMORY
LEARNER IMAGE
114
PREDICTION TAP CONSTRUCTING CIRCUIT
117
NORMAL EQUATION ADDER
118
PREDICTION COEFFICIENT DETERMINING CIRCUIT
119
MEMORY
TEACHER IMAGE
115
CLASS TAP CONSTRUCTING CIRCUIT
116
CLASSIFYING CIRCUIT
CLASS CODE

FIG.22

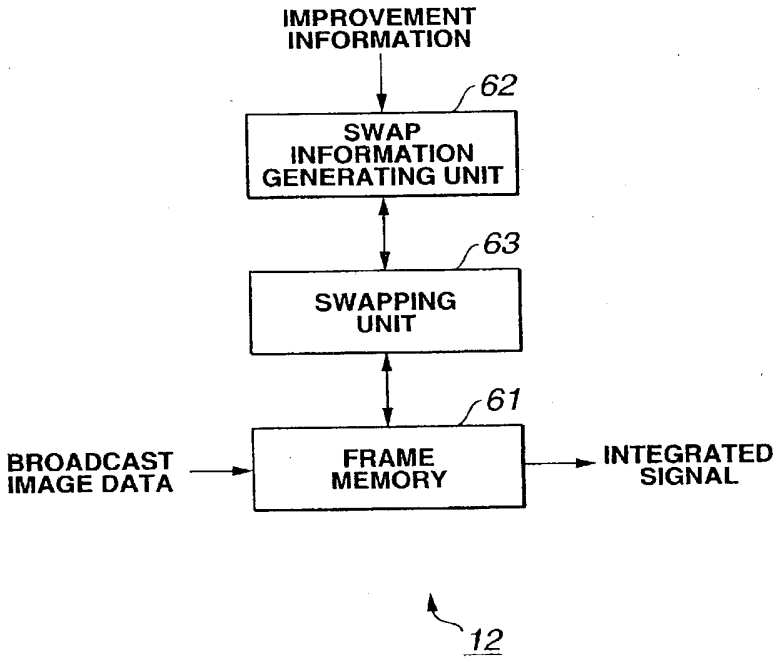

IMPROVEMENT INFORMATION
62
SWAP INFORMATION GENERATING UNIT
63
SWAPPING UNIT
61
BROADCAST IMAGE DATA
FRAME MEMORY
INTEGRATED SIGNAL
12

FIG.23

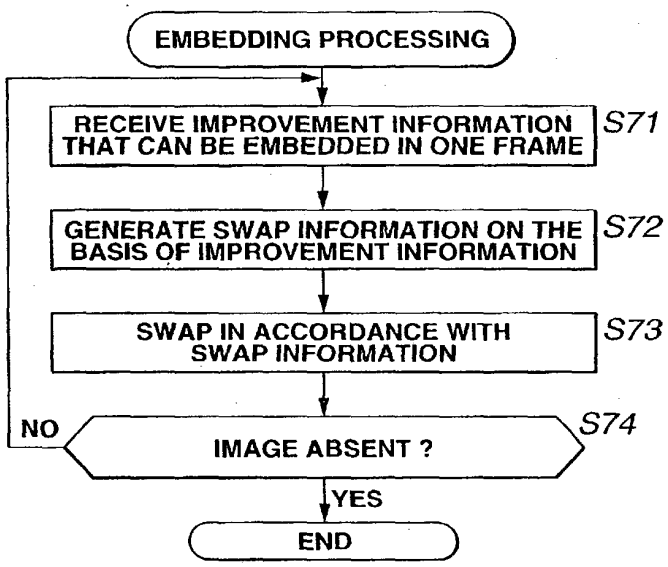

EMBEDDING PROCESSING
RECEIVE IMPROVEMENT INFORMATION THAT CAN BE EMBEDDED IN ONE FRAME
S71
GENERATE SWAP INFORMATION ON THE BASIS OF IMPROVEMENT INFORMATION
S72
SWAP IN ACCORDANCE WITH SWAP INFORMATION
S73
NO
IMAGE ABSENT ?
S74
YES
END

FIG.24

FIG.25A

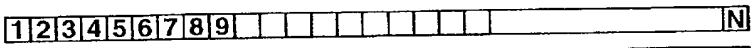



FIG.25B

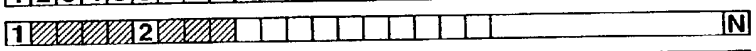



FIG.25C

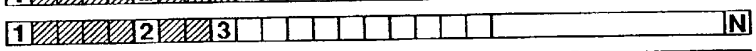



FIG.25D

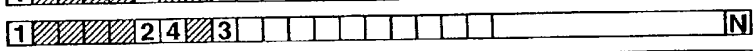



FIG.25E

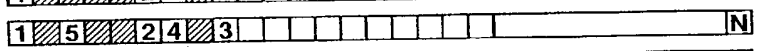



FIG.25F

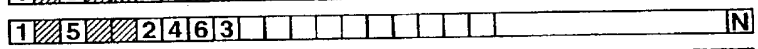



FIG.25G

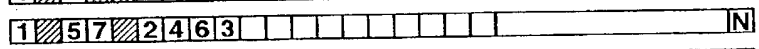



FIG.25H

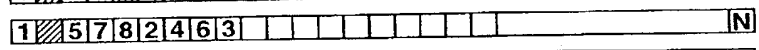



FIG.25 I

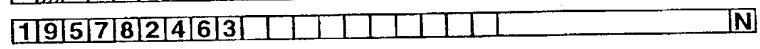



FIG.25J

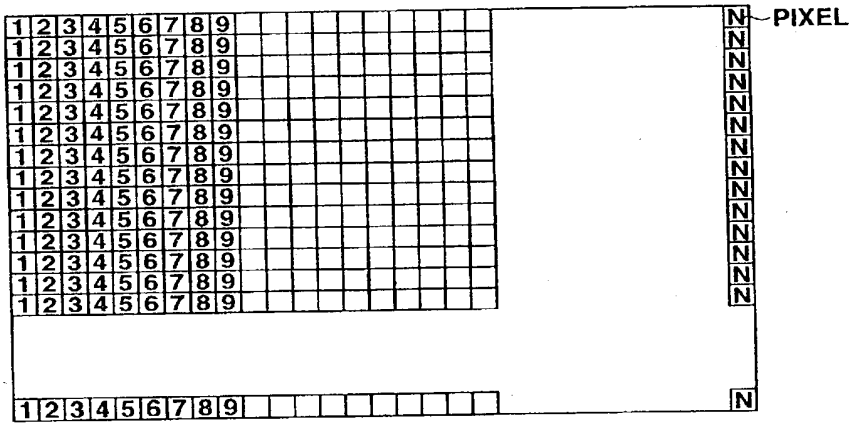
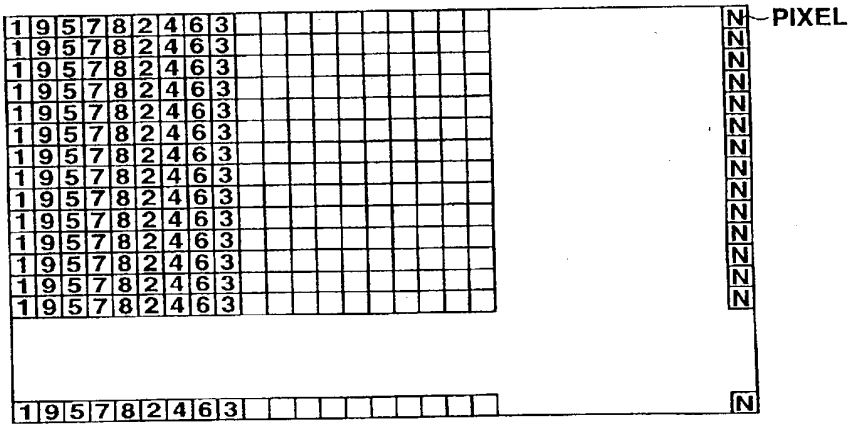



FIG.25K



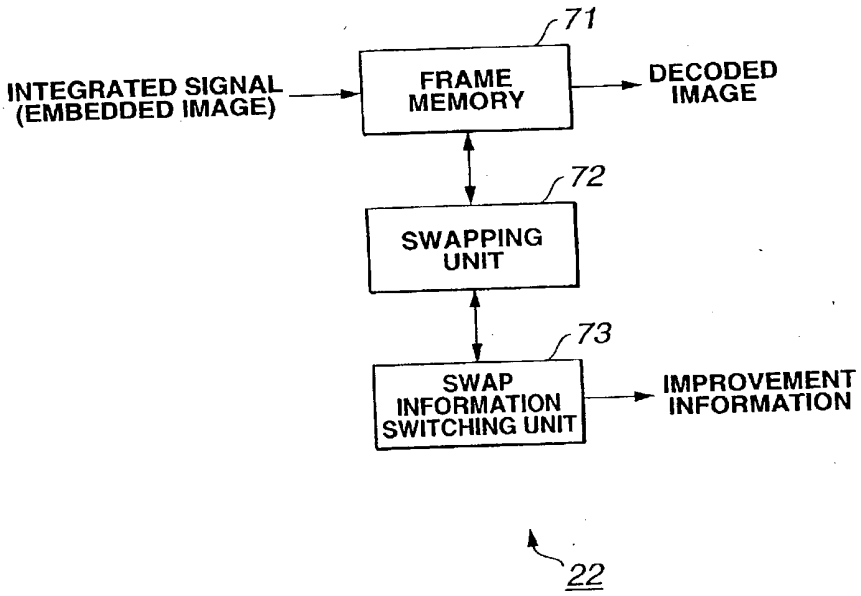

71
INTEGRATED SIGNAL
(EMBEDDED IMAGE)
FRAME
MEMORY
DECODED
IMAGE
72
SWAPPING
UNIT
73
SWAP
INFORMATION
SWITCHING UNIT
IMPROVEMENT
INFORMATION
22

FIG.26

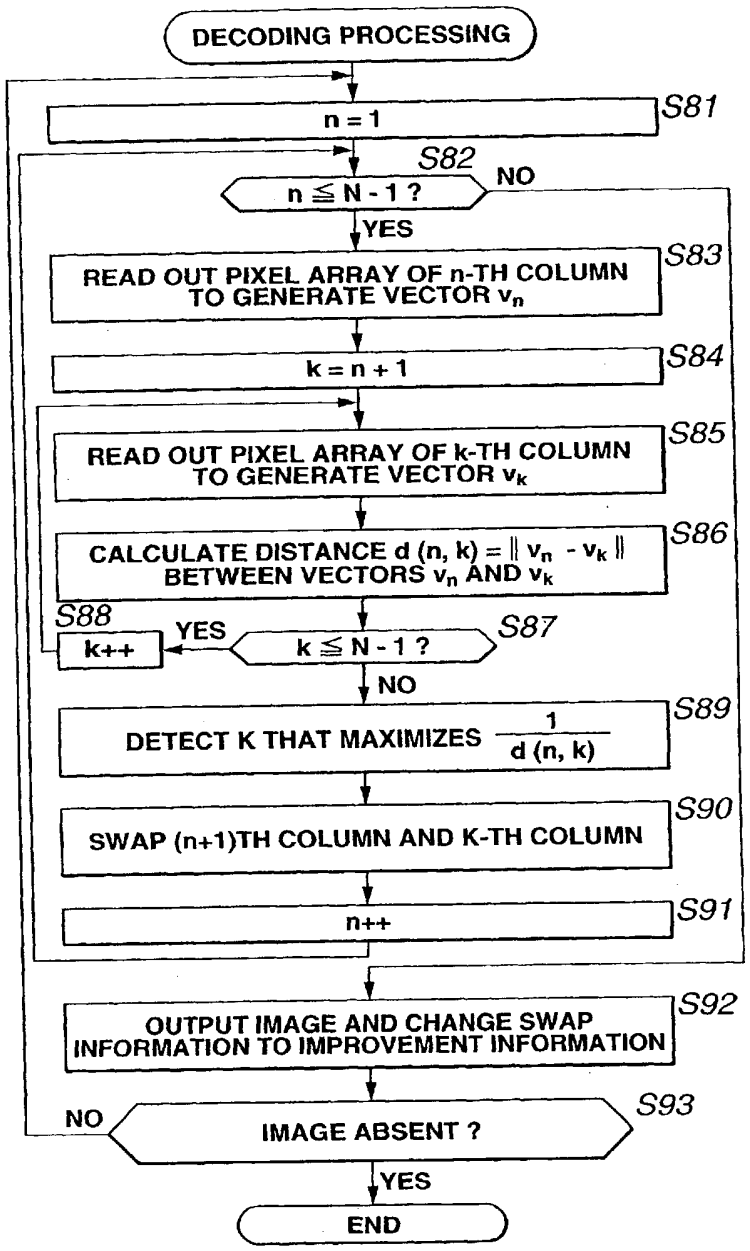

DECODING PROCESSING
n = 1
S81
S82
n ≦ N - 1 ?
NO
YES
READ OUT PIXEL ARRAY OF n-TH COLUMN TO GENERATE VECTOR $v_n$
S83
k = n + 1
S84
READ OUT PIXEL ARRAY OF k-TH COLUMN TO GENERATE VECTOR $v_k$
S85
CALCULATE DISTANCE d (n, k) = $\| v_n - v_k \|$ BETWEEN VECTORS $v_n$ AND $v_k$
S86
S88
k++
YES
k ≦ N - 1 ?
S87
NO
DETECT K THAT MAXIMIZES $\frac{1}{d(n, k)}$
S89
SWAP (n+1)TH COLUMN AND K-TH COLUMN
S90
n++
S91
OUTPUT IMAGE AND CHANGE SWAP INFORMATION TO IMPROVEMENT INFORMATION
S92
NO
IMAGE ABSENT ?
S93
YES
END

FIG.27

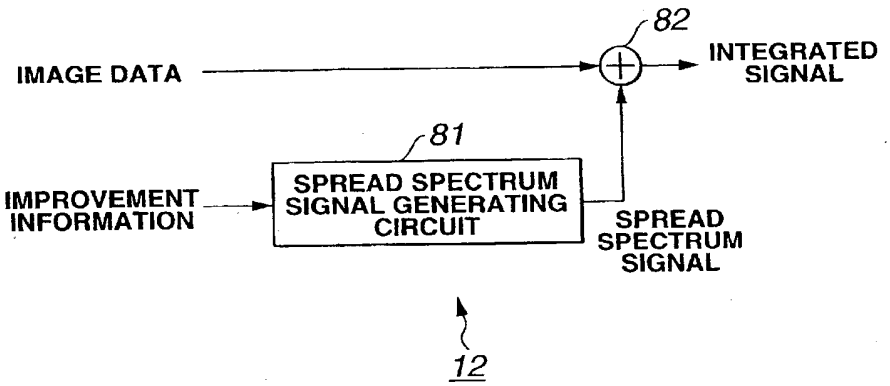

82
IMAGE DATA
INTEGRATED SIGNAL
81
IMPROVEMENT INFORMATION
SPREAD SPECTRUM SIGNAL GENERATING CIRCUIT
SPREAD SPECTRUM SIGNAL
12

FIG.28

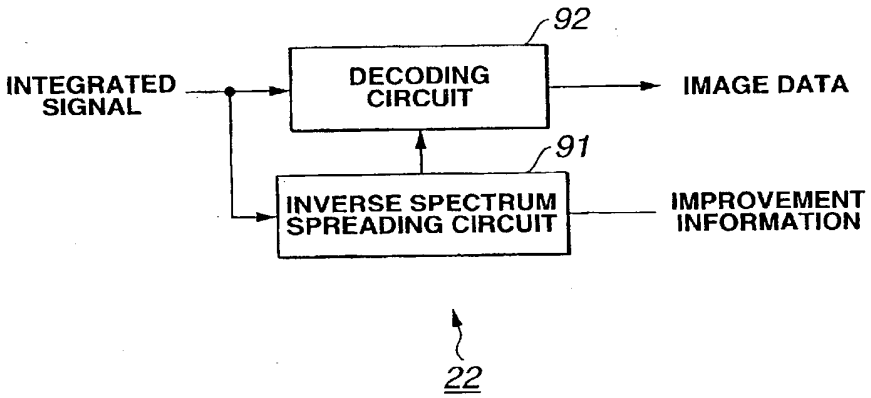

92
INTEGRATED SIGNAL
DECODING CIRCUIT
IMAGE DATA
91
INVERSE SPECTRUM SPREADING CIRCUIT
IMPROVEMENT INFORMATION
22

FIG.29

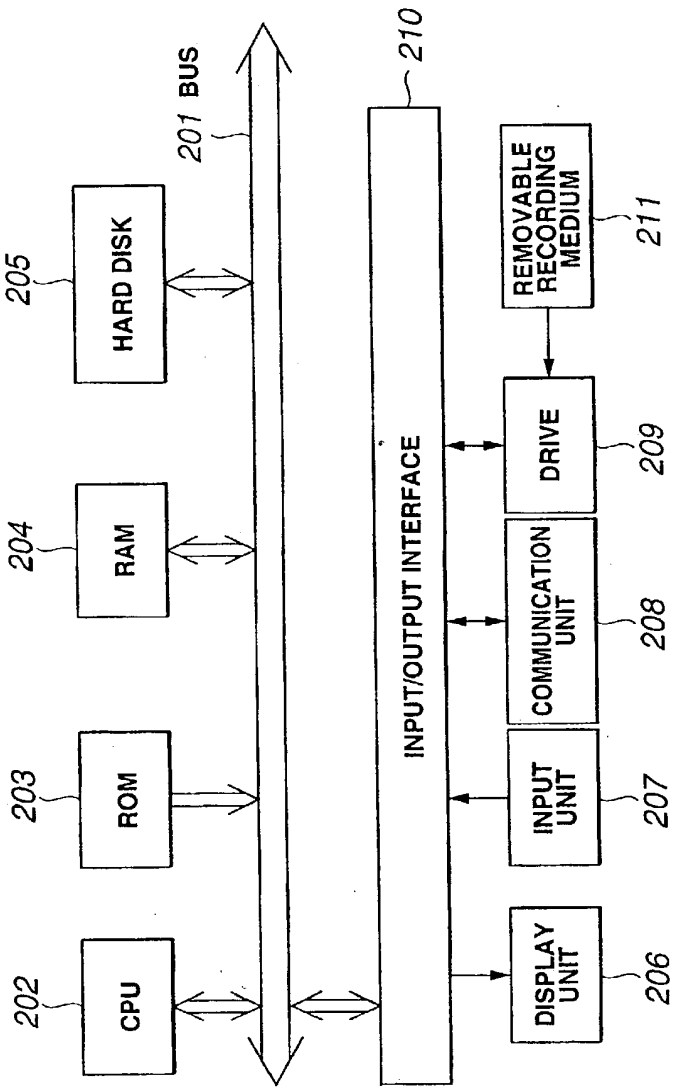

202
CPU
203
ROM
204
RAM
205
HARD DISK
201 BUS
210
INPUT/OUTPUT INTERFACE
206
DISPLAY UNIT
207
INPUT UNIT
208
COMMUNICATION UNIT
209
DRIVE
211
REMOVABLE RECORDING MEDIUM

FIG.30